REMARKS

Claims 1-6 and 8-15 are pending in the application.

Claim 7 has been canceled. Claim 1 has been amended to recite that component (B) comprises both vinylene carbonate and vinylethylene carbonate. Support for this amendment may be found in the specification at least at page 12, lines 8-13. Claims 4 and 6 have been amended to correctly depend from claim 1. No new matter has been added by these amendments, and entry is respectfully requested.

The Examiner has rejected claims 1-7 under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-5 and 7-9 of U.S. Patent No. 6,723,473 ("the '473 patent") in view of U.S. Patent Application Publication No. 2003/0118913 of Takami et al. ("Takami"). The Examiner has also rejected claims 1-9 and 12-13 and 15 under 35 U.S.C. § 103(a) as being unpatentable over Takami in view of WO 01/03228 ("WO '228"). Further, claims 10-11 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Takami in view of WO '228 and further in view of EP 0796510 ("EP '510"). The Examiner has also rejected claim 14 under 35 U.S.C. § 103(a) as being unpatentable over Takami in view of WO '228 and further in view of U.S. Patent Application Publication No. 2001/0018162 of Kida ("Kida") or U.S. Patent No. 6,090,506 of Inoue et al. ("Inoue"). Finally, claim 15 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over Takami in view of WO '228 and further in view of U.S. Patent Application Publication No. 2002/0001756 of Hamamoto ("Hamamoto"). Applicants respectfully traverse these rejections and the arguments in support thereof for the reasons set for previously on the record, which Applicants rely upon in full, and for the additional reasons which follow, and respectfully request reconsideration and withdrawal of the rejections.

The Present Invention

As previously explained on the record, the present invention is directed to a non-aqueous electrolyte secondary battery which contains a non-aqueous solvent containing: (A) a cyclic carboxylic acid ester; 0.5 to 20 volume % of (B) a cyclic carbonic acid ester having at least one carbon-carbon unsaturated bond; and (C) a cyclic carbonic acid ester having no carbon-carbon unsaturated bond. Component (B) comprises vinylethylene carbonate (VEC) *and* vinylene carbonate (VC). The combination of VC and VEC is particularly desirable because VEC

suppresses the reaction activity of VC at high temperatures to improve storage characteristics of the battery at such temperatures. Further, VEC is an important component of the non-aqueous electrolyte which is decomposed by reduction faster than the solvent at a slightly more noble potential than 0 V (Li/Li^+). Since the unsaturated bond is prone to polymerization, VEC undergoes a chain reaction on the negative electrode and rapidly forms a close and strong film on the negative electrode surface. This film serves as a physical barrier which inhibits the contact of solvent molecules around lithium ions with the negative electrode, thereby suppressing the reductive decomposition of the cyclic carboxylic acid ester on the negative electrode (see page 5, lines 18-25). As previously explained and demonstrated, the presence of $LiBF_4$ and $LiPF_6$ in a molar ratio of 1:9 to 9:1 in the solute (as recited in claim 14) improves cycle characteristics of the battery and decreases the amount of gas generated, and also results in favorable capacity maintenance rate and cycle life.

Double-Patenting Rejection Based on the '473 Patent in view of Takami

Regarding claims 1-7, the Examiner argues that the '473 patent discloses a non-aqueous electrolyte secondary battery, but acknowledges that the use of a cyclic carbonic acid ester having no carbon-carbon unsaturated bond is not taught. However, Takami allegedly discloses a non-aqueous electrolyte secondary battery comprising an electrode group containing a positive electrode, a negative electrode and a non-aqueous electrolyte including solvents and lithium salts dissolved therein. It is allegedly disclosed to use cyclic carbonates, such as ethylene carbonate (EC), propylene carbonate (PC), or vinylcarbonate (VC), together with γ-butyrolactone (GBL), and further to be desirable to prepare a mixed solvent including an aromatic compound. Various preferred combinations of non-aqueous solvents are allegedly taught, particularly in paragraphs [0061] and [0174] - [0176].

Therefore, the Examiner concludes that it would have been obvious to one having skill in the art at the time of the invention to use the cyclic carbonic acid ester having no carbon-carbon unsaturated bond of Takami in the electrolyte solution of the battery of the '473 patent because Takami teaches that it is desirable to use such a cyclic carbonic acid ester solvent in combination with other known solvents to improve the charge-discharge efficiency and cycle characteristics. Additionally, Takami allegedly teaches preferred combinations including GBL, EC and VC; GBL, PC and VC, and GBL, EC, PC and VC. Applicants respectfully traverse this rejection as

follows.

The non-aqueous solvent of the '473 patent contains a cyclic carboxylic acid ester and a cyclic carbonic acid ester having at least one carbon-carbon unsaturated bond. Although exemplary cyclic carbonic acid esters include VC and VEC, the combination of VC and VEC is not described nor included in any of the Examples. Takami teaches a mixed non-aqueous solvent which contains (GBL) as a main component, combined with a cyclic carbonate such as (PC), (EC), or (VC). However, Takami does not teach or suggest that that solvent may comprise VEC, or that the solvent *must* contain *both* VEC *and* VC in addition to a cyclic carboxylic acid ester (A) and a cyclic carbonate ester having no carbon-carbon unsaturated double bond (C) as claimed. Accordingly, even based on the proposed combination of the '473 patent and Takami, there would have been no motivation to utilize a combination of components (A), (C), VC and VEC as claimed. Further, Applicants have demonstrated that the use of the combination of VC and VEC results in a battery with a property which would not have been expected based on the proposed combination of the '473 patent and Takami: inclusion of VEC *and* VC dramatically reduces the amount of gas generated after cycles relative to the amount generated when only VC or VEC is included as component (B).

More specifically, as set forth in the enclosed Third Declaration of Atsushi Ueda Under 37 C.F.R. 1.132 ("Third Ueda Declaration") three different batteries were prepared from solvent mixtures each containing a cyclic carboxylic acid ester ((A), here, GBL); a cyclic carbonic acid ester ((C), here, EC); and a cyclic carbonic acid ester having at least one carbon-carbon unsaturated bond (B). Component (B) was either VC, VEC, or a combination of VC and VEC (Table 1, Series A). It can be seen from the data provided in Table 2 of the Third Ueda Declaration that surprisingly and unexpectedly, the addition of VC *and* VEC to a solvent mixture containing GBL and EC (battery 1) significantly decreased the amount of gas generated after cycles compared with batteries containing only VC (battery 2) or VEC (battery 3) and a similar mixture of (A) and (C). The decrease which was observed is dramatic: a reduction of 31% relative to VC (2.4 ml for battery 1 and 3.5 ml for battery 2) and 44% relative to VEC (4.3 ml for battery 3).

In sum, it would not have been expected based on the '473 patent, Takami, or their proposed combination that the addition of VC *and* VEC to a solvent mixture containing components (A) and (C) would significantly decrease the amount of gas generated after cycles.

Takami does not teach or suggest VEC, and neither Takami nor the '473 patent teaches or suggests the combination of VC and VEC. Accordingly, the results exhibited by the present invention would overcome any *prima facie* case of obviousness were one to be established, and the battery of the present invention comprising a non-aqueous solvent composed of a cyclic carboxylic acid ester (A), a cyclic carbonic acid ester (B) containing VC and VEC, and a cyclic carbonic acid ester (C) is non-obvious over the proposed combination of the '473 patent and Takami. Accordingly, reconsideration and withdrawal of the obviousness-type double patenting rejection based on the '473 patent in view of Takami are respectfully requested.

Rejection Under § 103(a) Based on Takami in view of WO '228

Regarding claims 1-9, the Examiner argues that Takami discloses the claimed non-aqueous electrolyte secondary battery, including the use of a non-aqueous electrolyte containing cyclic carbonates, such as EC, PC, or VC, together with gamma-butyrolactone, and further to be desirable to produce a mixed solvent. Various preferred combinations of non-aqueous solvents are allegedly taught, particularly in paragraphs [0061], [0174] – [0176], [0057] – [0059], and [0272] – [0275]. The Examiner also argues that Takami discloses the claimed positive and negative electrode materials and the employment of lithium salts, such as $LiPF_6$ and $LiBF_4$, as well as a solvent containing a benzene-like or derivative compound, as well as a specific solvent mixing solution in Example 41. The Examiner acknowledges that Takami does not disclose the specific use of vinylethylene carbonate (VEC) solvent or its volume percent as claimed.

However, WO '228 allegedly teaches a non-aqueous electrolyte secondary cell having an electrolyte which comprises a cyclic carboxylic acid ester as a non-aqueous solvent and a cyclic carbonic acid ester having at least one carbon-carbon unsaturated bond. In particular, the Examiner contends that WO '228 discloses the specific use of vinyl ethylene carbonate and derivatives thereof, that the content of the cyclic carbonic acid esters is preferably 0.5 to 20 volume %, and that the addition of other esters of not excluded. The Examiner argues that Examples 18-22 show the specific use of VEC added to the cyclic carboxylic acid ester.

Therefore, the Examiner concludes that it would have been obvious to one having ordinary skill in the art at the time of the invention to use the vinylethylene carbonate solvent of WO '228 in the battery of Takami since WO '228 allegedly discloses that such solvent addition provides a non-aqueous electrolyte secondary cell exhibiting a high electrical conductivity under

low temperature circumstances and also suppresses reduction decomposition. The Examiner contends that since Takami teaches the use of cyclic carbonic acid esters having at least one carbon-carbon unsaturated bond in a combination of mixed solvents, a cyclic carbonic acid ester can be interchangeably used to substitute another cyclic carbonic acid ester because they are deemed to be functionally and chemically equivalent.

Finally, the Examiner contends that Applicants' previous arguments that the prior art does not demonstrate the unexpected results exhibited by Applicants' invention, specifically for the inclusion of VEC and the specific molar ratios of the combined lithium salts, are not persuasive. Specifically, the Examiner argues that the data which were presented are not commensurate with the claims, noting for example that an increase in the initial charge/discharge efficiency is achieved only using 5% VEC, and is not shown for the entire claimed concentration range of 0.5 to 20 vol%. Similarly, the Examiner contends that the data of the Second Ueda Declaration still do not evidence unexpected results for the entire claimed $LiBF_4$ to $LiPF_6$ molar ratio of 1:9 to 9:1 because there is no significant difference between the claimed molar ratio and the unclaimed molar ratio, as evidenced by the capacity maintenance rate, nor were any unexpected results shown for the entire claimed range of 1:9 to 9:1, as evidenced by the cycle life or the amount of gas after cycles. Applicants respectfully traverse this rejection as follows.

In contrast with the present invention, while Takami teaches a mixed non-aqueous solvent, Takami is completely silent as to VEC. Takami thus does not teach or suggest that the solvent may comprise VEC, or that the solvent must contain VEC *and* VC in addition to a cyclic carboxylic acid ester (A) and a cyclic carbonic ester having no carbon-carbon unsaturated bond (C) as claimed. WO '228 also does not teach or suggest the combination of VC and VEC and none of the Examples of WO '228 contain such a combination of solvents. Accordingly, it would not have been expected based on the proposed combination of Takami and WO '228 that the inclusion of VC *and* VEC in the non-aqueous electrolyte of a secondary battery, as in the present invention, results in a dramatic decrease in the amount of gas generated after cycles compared to a battery in which the non-aqueous solvent contains only VC *or* VEC. Such a dramatic decrease has been explained in the Third Ueda Declaration and summarized above.

Claims 8 and 9 recite that the non-aqueous solvent further comprises a linear carbonic acid ester (D), such as dimethyl carbonate, ethyl methyl carbonate, or diethylcarbonate. As further set forth in the Third Ueda Declaration, five different batteries were prepared from

solvent mixtures each containing a cyclic carboxylic acid ester ((A), here, GBL); a cyclic carbonic acid ester ((C), here, EC); a linear carbonic acid ester ((D), here, DEC), and a cyclic carbonic acid ester having at least one carbon-carbon unsaturated bond (B). Component (B) was either VC, VEC, or a combination of VC and VEC (Table 1). It can be seen from the data provided in Table 2 of the Third Ueda Declaration that surprisingly and unexpectedly, the addition of VC *and* VEC to a solvent mixture containing GBL, EC, and DEC (battery 1G) significantly decreased the amount of gas generated after cycles compared with batteries containing only VC (battery 2G) or VEC (batteries 3G, 4G, and 5G) and a similar mixture of (A), (C), and (D). The decrease which was observed is dramatic: a reduction of 37% relative to VC (1.9 ml for battery 1G and 3.0 ml for battery 2G) and 50-55% relative to VEC (3.8 – 4.2 ml for batteries 3G – 5G), depending on the concentration of VEC in the 3G – 5G solutions. Accordingly, these unexpected results would overcome any case of *prima facie* obviousness, were one to be established, and reconsideration and withdrawal of the § 103(a) rejection based on Takami in view of WO '228 are respectfully requested.

Rejection Under § 103(a) Based on Takami in view of WO '228 and EP '510

Regarding claims 10-11, the Examiner acknowledges that Takami and WO '228 do not teach that the solvent comprises a glime. However, EP '510 allegedly discloses a non-aqueous electrolyte system consisting of a solvent mixture containing ethylene carbonate, γ-valerolactone and optionally containing one or more additional solvents selected from other organic carbonates such as glymes. The Examiner contends that EP '510 teaches that a mixture of solvents comprising glyme can be used in the electrolyte systems for batteries as they can be applied in a broad voltage range, have a conductivity higher than conventional conductivities at room temperature, and show a high stability against reduction. Therefore, the Examiner concludes that it would have been obvious to one skilled in the art at the time of the invention to use the solvent comprising a glime of EP '510 in the solvent mixture of Takami/WO '228. Applicants respectfully traverse this rejection as follows.

As previously explained and demonstrated, neither Takami nor WO '228 teaches or suggests utilization of a combination of VC and VEC in the non-aqueous electrolyte secondary battery, and Applicants' invention demonstrates unexpected results which would overcome any *prima facie* case of obviousness were one to be established. Specifically, it would not be

expected that inclusion of VC and VEC in a non-aqueous solvent containing cyclic carbonic acid esters (A) and (C) would dramatically decrease the amount of gas generated after cycles of the resulting battery, as exemplified by the present invention. EP '510 also does not suggest these results since EP '510 does not teach VC or VEC, nor a solvent which contains, in addition to VEC and VEC, a category (A) and a category (C) component. Accordingly, reconsideration and withdrawal of the § 103(a) rejection based on Takami in view of WO '228 and WP '510 are respectfully requested.

Rejection Under§ 103(a) Based on Takami in view of WO '228 and in view of Kida

Regarding claim 14, the Examiner acknowledges that even the proposed combination of Takami and WO '228 does not teach or suggest the claimed molar ratio of both lithium salts. However, Kida allegedly discloses a lithium secondary battery for which it has been reported that the charge/discharge cycle performance can be improved by using both $LiPF_6$ and $LiBF_4$ as the electrolytic salts of the non-aqueous electrolyte. Kida allegedly also discloses a specific example using a mixture of $LiPF_6$ and $LiBF_4$ in a molar ratio of 4:1. Accordingly, the Examiner contends that it would have been obvious to one having ordinary skill in the art at the time of the invention to use the specific molar ratio of both lithium salts, as taught by Kida, in the electrolyte-solvent mixture of Takami/WO '228 to improve the charge/discharge cycle performance and the capacity retention ratio. Applicants respectfully traverse this rejection as follows.

As previously explained, even if the proposed combination of Takami and WO '228 were valid, Applicants' invention demonstrates unexpected results which would overcome any *prima facie* case of obviousness were one to be established. Namely, it would not be expected based on the proposed combination of Takami and WO '228 that inclusion of VC *and* VEC in a non-aqueous solvent containing cyclic carbonic acid esters (A) and (C) would dramatically decrease the amount of gas generated after cycles. Kida also does not suggest these results, since Kida does not teach or suggest the claimed non-aqueous solvent containing a cyclic carbonic ester which contains VC *and* VEC. In particular, Kida teaches in paragraph [0016] that exemplary non-aqueous solvents include ethylene carbonate, propylene carbonate, and gamma-butyrolactone, but are preferably mixed solvents including diethyl ether to give good charge/discharge cycle performance. However, Kida does not teach or suggest VEC, nor a solvent which contains, in addition to VC and VEC, a category (A) and a category (C)

component. Accordingly, in view of the unexpected results of Applicants' invention, reconsideration and withdrawal of the §103(a) rejection based on Takami in view of WO '228 and Kida are respectfully requested.

Rejection Under § 103(a) Based on Takami in view of WO '228 and Inoue

Regarding claim 14, the Examiner acknowledges that even the proposed combination of Takami and WO '228 does not teach or suggest the claimed molar ratio of both lithium salts. However, Inoue allegedly discloses a non-aqueous secondary battery in which the electrolyte comprises one or more lithium salts. It is allegedly preferred to use an electrolytic solution comprising $LiPF_6$ and $LiBF_4$ incorporated in a mixture of organic solvents. The Examiner argues that Example 1 shows the use of an electrolyte comprising $LiPF_6$ and $LiBF_4$ in an amount of 0.9 mol and 0.1 mol per liter, respectively. Accordingly, the Examiner contends that it would have been obvious to one having ordinary skill in the art at the time of the invention to use the specific molar ratio of both lithium salts as taught by Inoue in the electrolyte-solvent mixture of Takami/WO '228 to improve the charge/discharge cycle performance and the capacity retention ratio. Applicants respectfully traverse this rejection as follows.

As previously explained, even if the proposed combination of Takami and WO '228 were valid, Applicants' invention demonstrates unexpected results which would overcome any *prima facie* case of obviousness were one to be established. Namely, it would not be expected based on the proposed combination of Takami and WO '228 that inclusion of VC *and* VEC in a non-aqueous solvent containing cyclic carbonic acid esters (A) and (C) would dramatically increase the initial charge/discharge efficiency. Inoue also does not suggest these results, since Inoue does not teach or suggest the claimed non-aqueous solvent containing a cyclic carbonic ester which contains VC and VEC. In particular, Inoue teaches in col. 12, lines 12-35 that the electrolyte contains at least one aprotic organic solvent such as PC, EC, butylene carbonate, etc., and preferably ethylene carbonate and/or diethylene carbonate. However, Inoue does not teach or suggest VC or VEC, nor a solvent which contains, in addition to VC and VEC, a category (A) and a category (C) component. Accordingly, in view of the unexpected results of Applicants' invention, reconsideration and withdrawal of the §103(a) rejection based on Takami in view of WO '228 and Inoue are respectfully requested.

Rejection Under §103(a) Based on Takami in view of WO '228 and in view of Hamamoto

Regarding claim 15, the Examiner acknowledges that the proposed combination of Takami and WO '228 does not disclose that the solvent comprises a derivative of benzene. However, Hamamoto allegedly teaches in the abstract that a non-aqueous electrolytic solution which may be used for a lithium secondary battery employs a non-aqueous electrolytic solution which comprises a non-aqueous solvent and an electrolyte which contains a biphenyl derivative. In view of these teachings, the Examiner concludes that it would have been obvious to one having ordinary skill in the art at the time of the invention to use the solvent of Hamamoto comprising a derivative of benzene in the solvent mixture of Takami and WO '228, as Hamamoto teaches that by using the benzene derivative as a solvent, a non-aqueous electrolytic solution which is favorably employable for a lithium secondary battery and which shows high battery performance, such as high electric capacity and high cycling performance, under maximum operation voltage condition or elevated temperature is obtained. Applicants respectfully traverse this rejection as follows.

As previously explained, even if the proposed combination of Takami and WO '228 were valid, Applicants' invention demonstrates unexpected results which would overcome any *prima facie* case of obviousness were one to be established. Hamamoto also does not suggest these results, since Hamamoto does not teach or suggest the claimed non-aqueous solvent containing a cyclic carbonic ester which contains VC and VEC. In particular, Hamamoto in paragraph [0018] teaches that the non-aqueous solvent preferably comprises a combination of a cyclic carbonate and a linear chain carbonate, a high dielectric constant solvent such as ethylene carbonate, propylene carbonate, or butylene carbonate, and a low viscosity solvent, such as γ-butyrolactone or dimethyl carbonate, for example. However, Hamamoto does not teach or suggest VC or VEC, nor a solvent which contains, in addition to VC and VEC, a category (A) and a category (C) component. Accordingly, in view of the unexpected results of Applicants' invention, reconsideration and withdrawal of the §103(a) rejection based on Takami in view of WO '228 and Hamamoto are respectfully requested.

In view of the preceding amendments, remarks, and Third Ueda Declaration, Applicants respectfully submit that all of the pending claims are patentably distinct over the prior art of record and in condition for allowance. A Notice of Allowance is respectfully requested.

Respectfully submitted,

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Encl: Petition for Extension of Time (two months)
Third Declaration of Atsushi Ueda Under 37 C.F.R. § 1.132
Request for Continued Examination (RCE)